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## Status and Management of the Black-capped Vireo at Fort Sill, OK, 1988-91

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by  
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Environmental regulations require Army installation land management personnel to protect endangered species on Army land. The black-capped vireo (*Vireo atricapillus*), which is on the Federal list of endangered species, occurs on the Fort Sill Military Reservation, OK, and also on military installations in Texas. Major threats to the species include nest parasitism by brown-headed cowbirds (*Molothrus ater*) and habitat loss.

The U.S. Army Construction Engineering Research Laboratories (USACERL) evaluated the distribution, abundance, dispersal, minimum survival, habitat requirements, and reproductive success of vireos on Fort Sill. A search of suitable habitat on the entire installation was conducted in 1988, and the locations, numbers, and reproductive success of the vireos were determined.

This study concludes that conditions at Fort Sill are favorable for the continued presence of vireos, and that the major threat to the vireo on Fort Sill and throughout its range is cowbird nest parasitism. The study recommends cowbird control measures to enhance vireo reproductive success, and continued annual monitoring and data collection on black-capped vireo numbers, age classes, and reproduction. Specific data-collection procedures are outlined. Options for other potential long-term research, monitoring and management considerations are also provided.

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## FOREWORD

This report was based on field studies conducted on Fort Sill from 1988 through 1991 for the U.S. Army Field Artillery Center and Fort Sill under Intra-Army Orders (IAOs) 888110, 889114, 890192, 891125, and 892231.

This research was done by the Environmental Natural Resources Division (EN) of the Environmental Sustainment Laboratory (EL), U.S. Army Construction Engineering Research Laboratories (USACERL). The USACERL principal investigator was Dr. David Tazik. Special thanks are due to E.J. Ardoín, CSM (Retired), William Bartush, Gene Stout, and Glen Wampler of the Fort Sill Natural Resources and Enforcement Division for their valuable assistance throughout the planning and execution of this work. David St. George and Beth St. George of Mabion, Washington collected the vireo habitat data. Base maps were created by Geri Larkin of the University of Oklahoma. Robin Musson assisted in compilation of this final report. William Severinghaus is Acting Chief, CECER-EN, and Dr. William Goran is Acting Chief, CECER-EL. The USACERL technical editor was William J. Wolfe, Information Management Office.

COL Daniel Waldo, Jr., is Commander and Director of USACERL, and Dr. L.R. Shaffer is Technical Director.

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# STATUS AND MANAGEMENT OF THE BLACK-CAPPED VIREO AT FORT SILL, OK, 1988-91

## 1 INTRODUCTION

### Background

The U.S. Army is responsible for managing 12.4 million acres of land on 186 major installations worldwide (U.S. Department of the Army [DA] 1989). Many of these lands are used for military training and testing activities, and many are also managed for nonmilitary uses, including fish and wildlife, forest products, recreation, agriculture, and grazing. Proper land management supports the military mission and multiple use activities, but also presents the Army with a unique challenge as public land steward.

In its effort to promote responsible land stewardship, the Army has initiated the Land Condition-Trend Analysis (LCTA) program, which uses standard methods to collect, analyze, and report natural resources data (Tazik et al. 1992a), and which is the Army's standard for land inventory and monitoring (Technical Note 420-74-3 1990). LCTA is a major component of the Integrated Training Area Management (ITAM) program, both developed at the U.S. Army Construction Engineering Research Laboratories (USACERL). The three other components of ITAM include: (1) Environmental Awareness, (2) Land Rehabilitation and Maintenance, and (3) Training Requirements Integration. LCTA promotes the principles of sustained yield, land stewardship, and multiple use of military land resources. The major objectives of LCTA are to: (1) characterize installation natural resources, (2) implement standards in collection, analysis, and reporting of the acquired data that enable compilation and evaluation of these data Army-wide, (3) monitor changes in land resource condition and evaluate changes in terms of current land uses, (4) evaluate the capability of land to meet the multiple-use demands of the U.S. Army on a sustained basis, (5) delineate the biophysical and regulatory constraints to uses of the land, and (6) develop and refine land management plans to ensure long-term resource availability.

Such programs help the Army comply with a variety of environmental regulations based on such legislation as the National Environmental Policy Act, the Endangered Species Act, and the Clean Water Act (Donnelly and Van Ness 1986). These regulations require land management personnel at Army installations to take measures to evaluate the impacts of military activities on natural resources including endangered species, on Army land. The black-capped vireo (*Vireo atricapillus*) was placed on the Federal list of endangered species in October 1987 (Ratzlaff 1987), and has been known to occur on the lands of the Fort Sill Military Reservation, OK. Reports of its occurrence on Fort Sill date as early as 1943 (Grzybowski et al. 1986), and as recently as 1985 and 1987 (Grzybowski 1985, 1988). The species is also abundant on military installations in Texas (Rust and Tazik 1990, Tazik et al. 1992b). This study to document the status of the vireo on Fort Sill was initiated by the U.S. Army in 1988.

The black-capped vireo is a small (10 g) migratory bird that breeds in parts of northern Mexico, Texas, and Oklahoma (Graber 1961, American Ornithologists' Union 1983). Birds arrive on breeding territories at Fort Sill during late April and early May, and occupy these sites through late July, August, or early September. Migration to wintering areas in western Mexico takes place during late summer and into the fall (August through September).

Habitat of the black-capped vireo is characterized by a patchy distribution of shrubs, shrub clumps, and small thickets with a few scattered trees. Poor soils that hinder tree growth, and fires that set back succession in scrubland areas can provide for good vireo habitat.

Major threats to the species throughout its range include nest parasitism by brown-headed cowbirds (*Molothrus ater*) and loss of its successional-stage habitat (Ratzlaff 1987). Cowbird nest parasitism has been documented at 80 percent and higher in unmanaged vireo populations in Oklahoma and parts of Texas (Grzybowski 1989a, 1990). Many occupied sites have a history of disturbance, primarily by fire, with subsequent regrowth of deciduous scrub plant species. Habitat deterioration can occur in a variety of forms from maturation of scrubland habitats to overgrazing and urban development (Marshall et al. 1985; U.S. Fish and Wildlife Service 1991). A continued study of the black-capped vireo is necessary to determine status and trends in populations and habitat of this endangered species.

## **Objectives**

The objectives of this work were to evaluate the distribution, abundance, dispersal, minimum survival, habitat requirements, and reproductive success of black-capped vireos on Fort Sill.

## **Approach**

A systematic search of suitable habitat on the entire installation was conducted in 1988. During 1989, 1990, and 1991, areas where vireos were detected in 1988 were revisited. Locations, numbers, and reproductive success of the vireos were determined. Site visits were made from May through late July. The findings from these visits were compiled and analyzed, and recommendations were made regarding the monitoring and management of vireo populations and habitat.

## **Mode of Technology Transfer**

The information developed as a result of this study should be transferred to installations and MACOMs as part of a handbook of threatened and endangered species on Army lands. The information also should be incorporated into the Army's Land Condition Trend Analysis (LCTA) Program database management system for Army-wide data summarization and dissemination. Also, a mechanism must be developed to update installation and species assessments through (1) direct input from installations and (2) expansion of and integration of data gathered in conjunction with the LCTA program.

## 2 METHODS

Eleven separate areas of Fort Sill were examined for the presence of vireos during 1988 (Figure 1). They were chosen based on a visual assessment of potential as vireo habitat through aerial and ground inspection prior to inventory work. Each area contained scrub habitat that appeared at least marginally suitable for vireos.

The presence, mated status, and nesting activity of all pairs of vireos were monitored routinely from May through July 1988, 1989, 1990, and 1991. From 1-1/2 to 4 hours were spent on a territory during each monitoring event.

Vegetation data were collected from within occupied and unoccupied areas at and near Arapaho Point and Mount Sherman to assess habitat selection variables of Fort Sill vireos. A modified version of the James and Shugart technique (1970) was used. Seven non-overlapping 0.04 ha circular sampling plots were randomly located in a grid pattern within each of five territories occupied by vireos, and in seven randomly located unoccupied areas. The following data were recorded within each plot:

1. Trees per 0.04 ha by dbh\* size class (3-6 in.,\*\* 6-9 in., 9-15 in., 15-21 in., 21-27 in., etc.); (0.28 ha per territory)
2. Shrub stems < 3 in. dbh per two, 30-m<sup>2</sup> belt transects per circle (420 m<sup>2</sup> per territory)
3. Ground cover at each of 20 points per circle (140 points per territory)
4. Vertical vegetation profiles at each of 20 points per circle (140 points per territory); this was quantified by counting the number of 1-dm intervals with woody vegetation contacts grouped by 5- or 10-dm interval along a 7.5 m vertical rod for each point.

A sample of the vireos present were banded with U.S. Fish and Wildlife Service numbered metal bands and colored bands to track individual birds during the breeding season, document site tenacity, and estimate minimum survival.

Captured vireos can be aged as HY (hatching year), SY (in their second calendar year of life, or first potential breeding season), and ASY (after second year; Grzybowski 1989c). The relative extent of gray in the napes of males is one criterion that can be used in aging. Those with an all gray nape are usually SY males. Those with a half-gray nape are usually ASY, as are those with full black caps. Tone differences in the primary coverts is a more reliable criterion in distinguishing SY and ASY age classes for both males and females in the hand. These coverts, which cover the outer set of flight feathers, are retained by SY birds from the earlier juvenile plumage. As such, they exhibit the paler, tan tone of the juvenile plumage compared to the blacker tone of adults. SY primary coverts also show more worn and tattered edges compared to adults. There are several reasons for this. First, these older feathers have had more time to wear. Second, these paler feathers wear faster than darker feathers. Finally, they are more loosely textured and tend to wear more rapidly than adult feathers.

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\* dbh = diameter at breast height (a unit of measurement for trees).

\*\* 1 in. = 25.4 mm.

Table 1

**Means and Standard Deviations of Selected Vegetation Variables  
Measured in Occupied and Adjacent Unoccupied Areas**

Vegetation Type	Quantities	
	Occupied (5 Areas)	Unoccupied (7 Areas)
<u>Stems &lt; 3 in. dbh/420 m<sup>2</sup></u>		
Blackjack oak (live)	738.0 ( 237.216)	693.6 ( 197.055)
Blackjack oak (dead)	243.0 ( 54.355)	249.0 ( 68.245)
Post oak	2.2 ( 4.919)	18.2 ( 20.902)
Skunkbush sumac	25.0 ( 38.105)	49.6 ( 64.340)
Smooth sumac	7.4 ( 10.188)	12.3 ( 24.838)
Virginia creeper	6.4 ( 8.019)	4.4 ( 5.503)
Hackberry	3.0 ( 4.123)	1.0 ( 1.915)
Other species	6.4 ( 10.431)	2.9 ( 7.559)
Total	1031.4 ( 261.491)	1030.0 ( 424.900)
<u>Trees/0.28 ha</u>		
3-6 in.	20.8 ( 5.070)	26.6 ( 15.230)
> 6 in.	2.8 ( 1.483)	2.1 ( 3.388)
Live	21.8 ( 5.933)	24.0 ( 11.605)
Dead	1.8 ( 0.447)	4.7 ( 2.984)
Total	23.6 ( 5.941)	28.7 ( 14.162)
<u>Ground Cover (# per 140 points)</u>		
Woody	80.6 ( 19.705)	80.0 ( 11.225)
Forb	17.0 ( 16.568)	16.7 ( 10.484)
Grass	72.2 ( 27.662)	59.6 ( 10.228)
Rock	48.6 ( 15.176)	75.0 ( 8.981)
<u>Vertical Profiles (# per 140 points)</u>		
0 - 5 dm	77.8 ( 20.167)	67.1 ( 14.029)
5 - 10 dm	147.4 ( 30.566)	134.4 ( 11.942)
10 - 15 dm	109.4 ( 20.526)	106.9 ( 14.519)
15 - 20 dm	72.0 ( 15.620)	74.1 ( 16.787)
20 - 25 dm	40.0 ( 15.748)	40.7 ( 14.908)
25 - 30 dm	29.0 ( 16.186)	18.9 ( 9.788)
Total < 30 dm	475.6 ( 66.108)	442.1 ( 64.142)
Total > 30 dm	19.0 ( 10.198)	11.1 ( 8.454)
GRAND TOTAL	494.6 ( 69.831)	452.3 ( 69.067)

Table 2

Banding, Aging, and Returns of Black-capped Vireos on Fort Sill, OK from 1988 to 1991

Site	Sex	Color Bands <sup>a</sup>	Age at Banding <sup>b</sup>	Year Banded and Returns <sup>c</sup>			
				1988	1989	1990	1991
Arapaho Point	Male	RS/R	SY	banded	—	—	—
Arapaho Point	Male	RS/B	ASY	banded	returned <sup>d</sup>	returned <sup>d</sup>	returned <sup>d</sup>
Arapaho Point	Male	Y/RS	SY	banded	—	—	—
Arapaho Point	Male	O/BS	ASY	banded	—	—	—
Mount Sherman	Male	YS/Y	ASY	banded	returned	—	—
Mount Sherman	Male	OS/R	SY?	banded	(returned) <sup>e</sup>	returned	—
Mount Sherman	Male	RS/O	SY	banded	returned	returned	returned
Mount Sherman	Male	BS/B	ASY	banded	—	—	—
Mount Sherman	Male	BS/Y	SY	—	banded	returned	returned
Mount Sherman	Male	S/RB	ASY	—	—	—	banded
Mount Sherman	Female	BS/-	SY	banded	—	—	—
Mount Sherman	Female	BS/Y	ASY	—	—	banded	—
Wichita Mtns. WR	Female	-/BkS	HY	(banded 1987)	returned <sup>f</sup>	—	—
Mount Sherman	Unknown	BkS/-	HY	banded	—	—	—
Mount Sherman	Unknown	S/-	HY	—	—	banded	—
Mount Sherman	Unknown	S/-	HY	—	—	banded	—
Mount Sherman	Unknown	S/-	HY	—	—	banded	—

<sup>a</sup>B=Blue; Bk=Black; O=Orange; R=Red; S=Silver metal band; Y=Yellow.<sup>b</sup>SY=in second calendar year of life; ASY=after second calendar year of life.<sup>c</sup>Dashes indicate bird not detected, or not yet banded.<sup>d</sup>Returned to Bushman Mountain area of the Wichita Mountains WR.<sup>e</sup>Not detected, but assumed present because of detection in 1990.<sup>f</sup>Returned to Mount Sherman Area.

### **3 RESULTS AND DISCUSSION**

#### **Distribution and Abundance**

During 1988, 17 to 18 adult vireos (10 males and 7 to 8 females) were observed at the Fort Sill sites (Figures 1 and 2). All but one of the males were located in the vicinities of Mount Sherman and Arapaho Point. The additional male was observed south of Pratt Hill. These same areas were revisited in 1989 at which time only three males and three females were observed, all at the Mount Sherman area site (Figure 3).

During 1990, five males and three females were located in the Mount Sherman area (Figure 4). One of these males, originally banded in 1988 and not detected in 1989, was discovered in 1990. This male was likely overlooked in 1989, or may have been unmated and moved to another locality before surveys were conducted. Thus the 1989 count of males should be increased to four males. The Arapaho Point area was searched again in 1990, but no vireos were detected.

During 1991, five males and three females were again located on Fort Sill. However, only four males and two females were located in the Mount Sherman area; the other pair was found at the Arapaho Point site (Figure 5).

The decline of about 60 percent from 1988 to 1989 is typical of some of the natural variability that can occur in small groupings of vireos. There is no indication that the decline on Fort Sill resulted from military activities. A general decline between 1988 and 1989 was also noted on the Wichita Mountains Wildlife Refuge (WR), and both may have a common cause (Grzybowski 1989a, 1989b).

#### **Habitat Analysis**

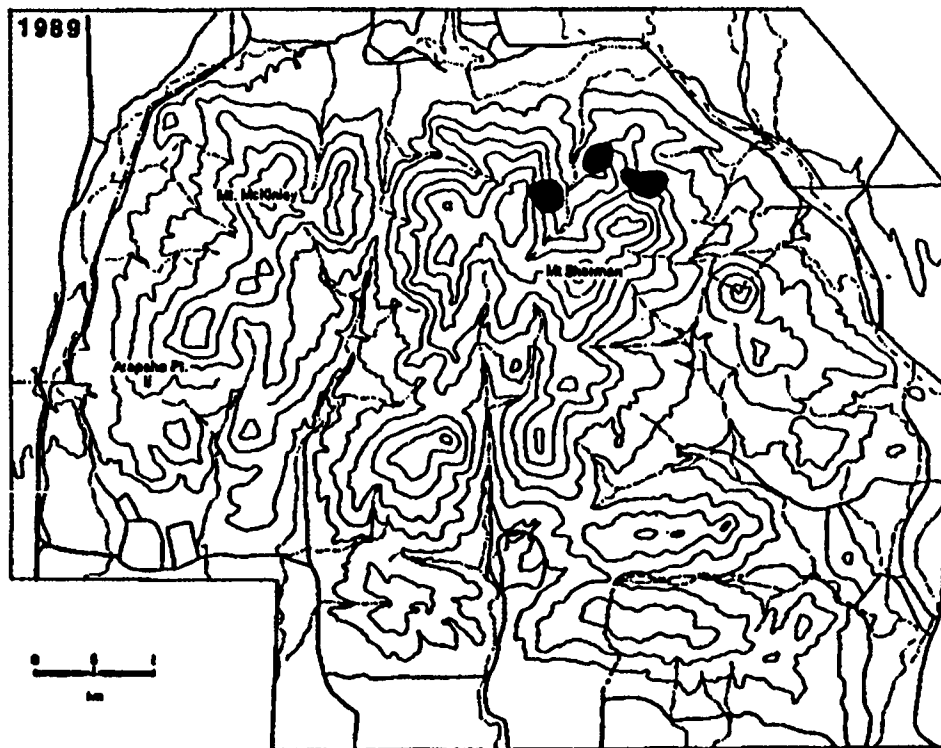
Vegetation data are summarized in Table 1. Using t-tests, none of the vegetation variables exhibited significant differences between occupied and unoccupied areas. In fact, the two groups have remarkably similar data. Notwithstanding, the small sample size limits conclusions with regard to the management implications of these results. Also, the small size of the black-capped vireo population itself may make interpretation of the results difficult. That is, unoccupied areas may be unoccupied because of the limited number of birds, and not because of undetected differences in habitat. Thus, more vireos might inhabit the Fort if vireo reproduction was enhanced. In addition, the drop in numbers between 1988 and 1989 was not accompanied by any discernible change in habitat.

Analysis of the Fort Sill vireo habitat data in combination with habitat data from other parts of southwestern and west-central Oklahoma, primarily the Wichita Mountains WR, reveals that Oklahoma vireos prefer areas with abundant deciduous vegetation in height zones under 2 m, and, to a lesser extent, are found in areas with greater heterogeneity in the volume of this vegetation strata compared to unoccupied scrub habitat (Grzybowski 1989a). This is also consistent with data from other parts of the vireo's range (Grzybowski et al. ms).

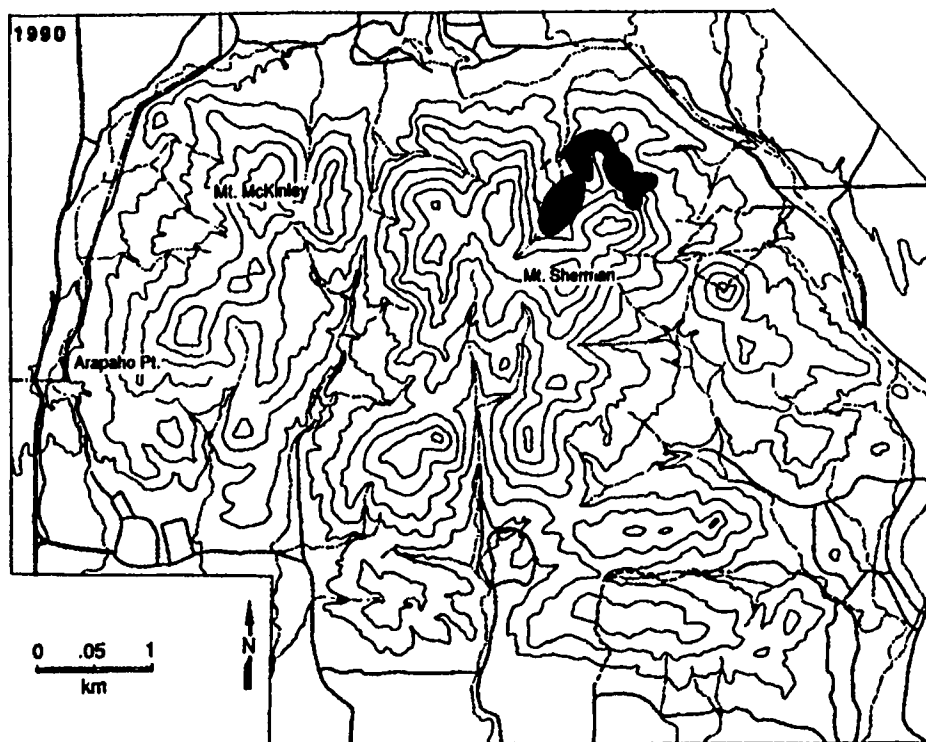
#### **Banding**

During 1988, 8 of 10 males, one of 7 or 8 females, and one of 6 to 9 young observed were banded (Table 2). Only one male was banded in 1989. The other three males present were already banded. In 1990, one female and three young were banded. In 1991, one male was banded.

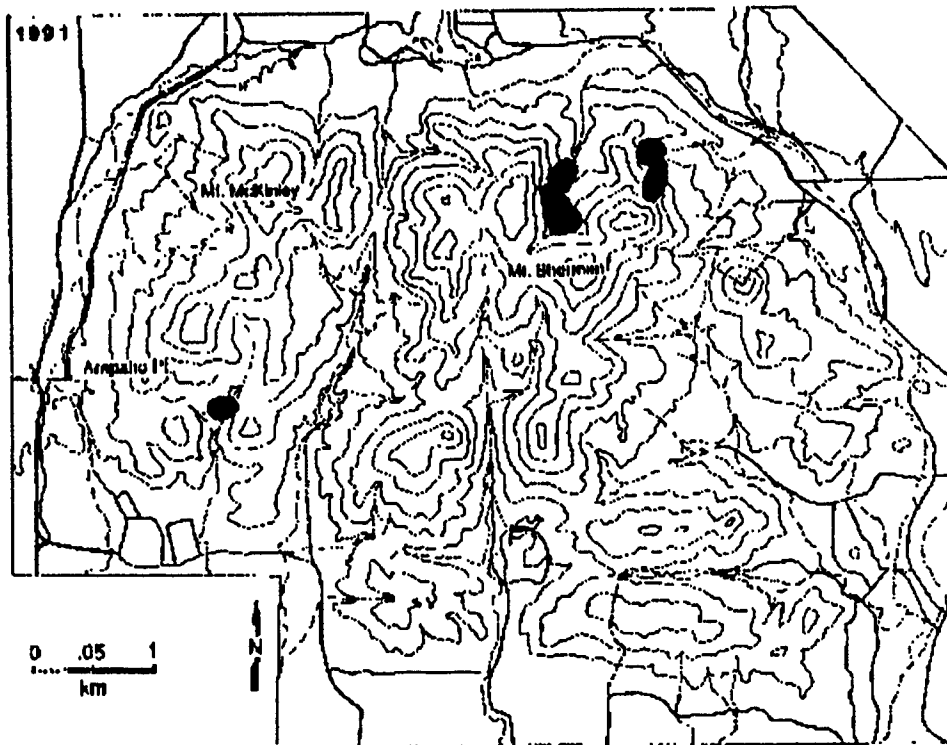




**Figure 3. Locations of Black-capped Vireo Territories on Fort Sill at Mount Sherman During 1989.**



**Figure 4. Locations of Black-capped Vireo Territories on Fort Sill at Mount Sherman During 1990. (Dashed lines indicate temporary territory.)**



**Figure 5. Locations of Black-capped Vireo Territories on Fort Sill at Arapaho Point and Mount Sherman During 1991.**

Of the eight males banded in 1988, two were detected on the Fort in 1989, and a third, missed in 1989, was found in 1990. One additional male, banded on the Fort in 1988, maintained a territory in the Bushman Mountain area of the Refuge approximately 8 km away (Table 2). This yields a minimum survival of 50 percent for the 1988-1989 period. Two of three banded males known to be present on the Fort at the end of the 1989 season were detected in 1990. With a 1988-banded male missed in 1989 but detected in 1990, and the Fort Sill banded male that maintained a territory on the Refuge in 1989 and 1990, minimum survivorship for the 1989-1990 period was 80 percent. Of the four males detected in 1990, three (75 percent) were observed in 1991—including the bird that has maintained a territory on the Refuge. Pooling data between years, the 1-year detected return was 65 percent (11 of 17).

Banding of females with active nests was avoided to minimize the likelihood of nest desertion. Opportunities to band females were thus limited to the time of fledging or the post-fledging period. The one female banded in 1988 was not observed during 1989 or 1990 on the Fort or on the Refuge. A female banded in 1990 was also not detected during 1991.

The one young banded on the Fort in 1988 was not observed again, nor were any of the three young banded as fledglings in 1990. However, a female banded as a fledgling on the Refuge in 1987 was observed at the Mount Sherman site in 1989, but was not detected in 1990.

## **Aging**

Five of the 10 males observed in 1988 were aged as SY. This is a higher percent than reported at other sites (Grzybowski 1989c), and suggests that dispersal of young from the Refuge (where successful efforts to control cowbird nest parasitism was occurring) might bolster the number of birds on Fort Sill.

However, this high ratio of SY males did not persist in 1989. Only one of the adult male vireos detected on the Fort during 1989 was aged as SY. Two of the other three males were aged as SY in 1988, and were thus in their third calendar year (TY) in 1989. A banded female, aged HY in 1987 and observed on the Fort in 1989, was also TY.

In 1990, only one of the four males observed was aged SY. The three others had been banded in previous years. A fifth bird was heard, but not seen, on only one visit, and was countersinging against one of the banded males. This bird was not present on any subsequent visits, though a bird, possibly this bird, was heard (but not seen) singing briefly near the road downhill from the vireo territories in mid-June.

In 1991, only one of the five males observed was aged SY. This was the male discovered below Arapaho Point. One of the unbanded males in the Mount Sherman area had a half-gray nape and was aged ASY when captured. The other three males were entirely black-capped, including two previously banded.

The female banded on Fort Sill in 1988 was aged as SY. The female banded in 1990 was aged ASY.

## **Territory Monitoring**

During 1988, nine territories were monitored regularly: five at Arapaho Point, and four at Mount Sherman. The lone male observed near Pratt Hill in 1988 was unmated and observed on only two occasions. Three territories were monitored in 1989. A fourth male banded in 1988 and detected in 1990 was not observed in 1989. Four territories were monitored in 1990. A fifth male was present on only one visit in 1990. Five territories were monitored during 1991, though an unmated male at the Mount Sherman area could not be located in June, and the SY male and his mate at Arapaho Point were also not present in June.

## ***Mated Status***

Seven of 10 males were mated in 1988, three of the four in 1989, three of five in 1990, and three of five in 1991 for a total of 16 of 24, or 67 percent. This compares with a 69 percent mating success among 98 vireo males monitored in Oklahoma from 1984 to 1987 (Grzybowski 1988). One additional male was seen with a female for only a short period during 1988, and is considered here to be unmated.

## ***Nestings***

Sixteen active nests were observed on Fort Sill over the 3 years of the study (Table 3). Three nests were abandoned during construction, and seven others were parasitized. Five of the parasitized nests were abandoned or predated; one produced young; and another was terminated by the investigator. One additional nest was found just after it had been predated, probably by a mammal, and two unparasitized nests were unsuccessful, also as a result of predation. The remaining three unparasitized nests fledged vireo young. Two additional nestings were observed (both in 1989) after young had left the nest.

Table 3

**Summary of Black-capped Vireo Territory Monitoring Data  
for Fort Sill, OK from 1988-1990**

Categories	Counts				
	1988	1989	1990	1991	Total
No. of territories monitored	10	3 <sup>a</sup>	5	5	23
No. of males mated	7 <sup>b</sup>	3	3	3	16
Percent of males mated	70%	75% <sup>a</sup>	60%	60%	70% <sup>a</sup>
<b>Nesting:</b>					
Total active nests observed, during:	9	2	2	3	16
Construction	2	1	1	0	4
Egg-laying	0	1	0	2	3
Incubation	5	0	0	0	5
Nestling stage	0	0	1	1	2
Fledgling stage	1	0	0	0	1
Inactive	1	0	0	0	1
<b>Nest fate:</b>					
Abandoned	3	2	1	1	7
Predated	2	0	0	2 <sup>c</sup>	4 <sup>c</sup>
Undetermined	1	0	0	0	1
Fledged Vireos	3	0	1	0	4
Total broods found without nests	0	2	0	0	2
Total nestings observed	9	4	2	3	18
<b>Parasitism:</b>					
No. of parasitized nests <sup>c</sup>	3	2	0	2	7
No. of unparasitized nests	3	0	1	1	5
Percent Parasitized	50%	100%	0%	67%	58%
<b>Production:</b>					
Vireo eggs observed	17	5	0	5	27
Cowbird eggs or young observed	5	3	0	4	12
Vireo young produced	6-9	4-5	3-4	0	13-18
Young/mated pair/year	0.9-1.3	1.3-1.7	1.0-1.3	0	0.8-1.1

<sup>a</sup>One additional banded male found in 1990 was not detected in 1989, and was considered unmated.

<sup>b</sup>One additional male was temporarily mated.

<sup>c</sup>Based only on those nests with eggs or young in, or associated with, the nest.

<sup>d</sup>All cowbird eggs or young were removed from vireo nests.

<sup>e</sup>One with cowbird nestling, terminated by investigator.

### *Cowbird Parasitism*

The brown-headed cowbird does not raise its own young. Rather, it lays its eggs in the nests of other species. The black-capped vireo appears particularly susceptible to cowbird parasitism, and its reproductive success suffers as a result. The cowbird's shorter incubation time and more rapid rate of development on hatching all but precludes successful fledging of vireos from parasitized nests. Seven of eleven nests found with either eggs or young in the nest were parasitized. One nest, found empty but with recently fledged vireo young nearby, was considered unparasitized. Thus, incidence of parasitism was 58 percent (7 of 12).

### *Production*

All cowbird eggs were removed from each of six parasitized nests in an attempt to enhance vireo production. This proved fruitful in only one nest as all others were abandoned or predated subsequent to cowbird egg removal. A 5-day old cowbird chick was removed from a seventh nest. Approximately 13 to 18 young were produced on Fort Sill over the 4-year period. None were produced in 1991. Pooling numbers among years, the annual success per pair was 0.8 to 1.1. This is not believed adequate to maintain or expand this population.

#### 4 MANAGEMENT, RESEARCH, AND MONITORING OPTIONS

The primary goal of the program to monitor the black-capped vireo in the Wichita Mountains is to develop and maintain a viable and secure population (U.S. Fish and Wildlife Service 1991). Current perceptions are that such a population should number between 500 and 1000 pairs (Pease and Gingerich 1989). The Wichita Mountains population may be the only viable one left in Oklahoma, as the numbers of vireos in Blaine County are very low and are at high risk, and the Caddo canyonlands group may be extinct with virtually no prospects or courses of action for recovery. The Fort Sill population will thus figure significantly in the effort to maintain the vireo population in this area, as substantial areas of suitable and potential habitat occur on the installation. The primary activities to be continued and/or developed include: (1) management directed at expanding the Wichita Mountains population, (2) research useful at directing and improving management, and (3) monitoring to determine the success of management.

While it was hoped that the groups present on the Fort would build by immigration from the Refuge and from some enhancement of reproductive success, this has not occurred. Further actions are necessary, including a more comprehensive long-term strategy to maintain and increase vireo numbers and stability on Fort Sill to the extent that this does not constrain the military mission.

Two specific concerns that must be addressed are cowbird nest parasitism, and maintenance of suitable habitat. The basic plan outlined below focuses on developing existing groups through more intensive cowbird control measures, and in integrating a system of habitat management to ensure that suitable habitat will be available for the expanding population. This management should be applied on the western portion of Fort Sill where land supporting vireo habitat is present.

##### *Cowbird Nest Parasitism*

Among the recovery and management tasks, dealing with cowbird nest parasitism is probably of highest importance as it directly enhances reproductive success. Currently, cowbird eggs are being removed from vireo nests. While some enhancement has been achieved elsewhere, overall, this has proven to have limited value on Fort Sill. Vireos often abandon parasitized nests before cowbird eggs can be removed. Nests can be re-parasitized and abandoned even after eggs are removed. Cowbirds frequently remove vireo eggs, thus reducing vireo clutch size. Finally, cowbirds may interfere with active vireo nests advanced beyond the egg-laying stage.

Given the poor reproductive success of vireos on Fort Sill between 1988 and 1991, a cowbird trapping program is recommended. This program should include:

1. Procedures for determining trap placement and assessment of trap influence zones
2. Details of cowbird trap design and construction
3. Instructions for cowbird trap operation
4. Procedures for assessing the impact of the trapping program on vireo reproductive success.

##### *Cowbird Trap Placement and Influence Zones*

Cowbirds routinely travel between areas where they parasitize nests, afternoon feeding areas, and roosting areas. Distances between these points are usually measured in kilometers. Because no cattle are present in or near the vireo areas of Fort Sill, most cowbirds impacting vireos on Fort Sill likely travel from pastures on the adjacent Refuge where buffalo and longhorns are present. Pastureland to the south may also serve as a source of cowbirds.

An assessment of cowbird trap influence zones indicates that these zones may have a radius of 1 km or more, depending somewhat on features of contour and presence of cattle (Grzybowski 1989a). These influence zones are often delimited by ridge lines at the upper reaches of watersheds, particularly in areas with moderate to high relief. Cowbirds are often observed traveling up draws.

However, these assumptions should be verified for vireo areas on Fort Sill. A sampling scheme using fixed points in morning hours that records directions and times of movements will likely express the patterns of movements into and out of the current vireo nesting areas. Observations from below and above the current vireo nesting areas are recommended. These data can be collected with 3 to 5 mornings of observation for each location. This will help in placement of traps to enhance effectiveness. Some searches for cowbird feeding areas during afternoon periods may help identify whether feeding areas occur on the installation. These feeding areas, if present on Fort Sill, have potential as effective trap sites. Conversely, it may be possible to create feeding areas attractive to cowbirds to attract them to specific trapping sites.

In general, traps should be placed at the entrances to draws, or below, but near the vireo nesting areas. Initially, two traps should be used in the Mount Sherman area. They should be placed in the open, near trees in low areas, but away from flood zones. Other approaches for assessing trap influence zones are discussed below.

#### *Cowbird Trap Design and Construction*

Cowbird-removal traps should be designed according to the recommendations of U.S. Department of Interior leaflet (1973), but modified to smaller dimensions (8 ft x 12 ft x 6 ft),\* and with more predator-resistant materials. The traps are usually constructed of panels that can be easily assembled and disassembled. The traps use decoy cowbirds to attract others, and have a funnel entrance, usually at the top, which allows birds to enter, but which most birds do not recognize as the exit. The use of a mobile trap should be considered (i.e., one placed on an axle for transit from location to location), though this may not be possible in some locations.

Predators, especially raccoons, have been a variable but continuous problem at many trapping locations (Grzybowski 1992). More predator resistant materials need to be used than recommended in the USDI leaflet. One-inch mesh chicken wire may be too large as it allows raccoons to reach in to grab and kill cowbirds.

In addition, it may be necessary to place floors in the traps and aprons along the edges to discourage burrowing from below or along the sides. Small electrical fence units have been used to discourage predators from climbing onto the traps, harassing the cowbirds, and grabbing and pulling cowbirds through the mesh (Grzybowski 1992).

Adequate internal perches should be provided to prevent cowbirds from perching along the walls. However, the perches need to be placed such that cowbirds are not afforded a view of the funnel entrance. Disposing of removed cowbirds near the trap locations should be avoided as this may attract and heighten the persistence of raccoons and other unwanted predators.

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\*1 ft = 0.305 m.

### *Cowbird Trap Operation*

Once constructed, decoy cowbirds need to be placed in the traps. The recommended number is about four males and two females. The traps should be provisioned with food, water, and shade in addition to internal perches. Food should be placed in a large bare area below the funnel entrance. Operation then simply becomes a matter of maintaining this environment, removing excess cowbirds, and recording the captures and other significant events.

When the traps are operating well, their operation is perfunctory, and they may need limited attention 1 day in 2-4. However, when traps are not operating effectively they may need substantial daily attention by individuals who understand how the traps operate, can determine the problem, can assess what needs to be done specifically to correct the problem, and can go about performing the correction.

A basic instruction session and/or manual should be provided for individuals operating the traps to ensure adequate understanding of how the traps work. Basics on social behavior of the cowbirds (including male-female interactions), how cowbirds approach and enter traps, their behavior in the traps, and what "trick" keeps them in the traps should be included. With this knowledge, the instructions on designing and maintaining the traps should take on more meaning, thus increasing attention given to important details.

A rotation of individual decoy cowbirds in the traps may help maintain the capture potential longer through the season. Traps typically have high initial capture rates, followed by lower captures (Grzybowski 1990). While cowbird numbers are initially reduced, the ability of traps to capture recent immigrants wanes. Apparently, the behavior of the decoy cowbirds changes with time in ways that deter additional cowbirds from being captured (Grzybowski, pers. obs.). Staggering start-up times of traps, or generating a pool of freshly trapped birds from another source (mist netting or mobile trap) could be useful.

### *Measuring the Effects of Cowbird Management*

While cowbird trapping has clearly reduced nest parasitism at many sites where it has been applied, the results are not always uniform, and some efforts may not be adequate. Thus, monitoring the effects of management will allow feedback for any adjustments that may be necessary.

The clearest effect of cowbird removal is in reduction of nest parasitism and increased production of vireo young. Monitoring of vireos provides this measure of success. For the small number of birds present on the installation, this is still the most appropriate approach. If numbers grow, an alternative sampling scheme may be more appropriate.

Banding (particularly of young) to determine dispersal and recruitment is an important research component of this monitoring. Banding will help distinguish between recruitment from Fort Sill reproduction and immigration from the adjacent Refuge. These data will also help match habitat management, surveys, and trapping efforts with the dispersal potential of the vireo.

### *Habitat Management and Monitoring*

In western Oklahoma, the vireo occupies a midsuccessional stage in scrubland habitat. Sites with suitable substrate recovering from some level of disturbance (mostly fire) appear to generate the best habitats for vireos. The primary site that has developed into vireo habitat in the Wichita Mountains WR and is currently occupied had a relatively recent history of fire. This pattern has been replicated at a

number of places across the vireo's range (Grzybowski et al. MS). Maintenance of existing vireo habitat on Fort Sill will require periodic management, including use of fire.

Burns regularly occur in portions of Fort Sill, and have occurred near some of the vireo nesting areas since the study began in 1988. These burns should be mapped and evaluated in terms of how and if they influence the generation of black-capped vireo habitat. A number of factors can then be integrated into a general fire and habitat management strategy for the installation. Those specifically affecting the vireo are: (1) the rates at which vireo habitat develops after a disturbance, (2) the life expectancies of suitable habitat, (3) the nature and intensities of the burns creating suitable habitat, (4) the expected expansion of the local vireo population, and (5) the ultimate balance in maintaining a suitable amount of habitat in the appropriate successional stage for the expected target vireo population. Another important factor to consider is the effect of fire on the shallow soil areas of the Fort, including vireo areas.

Because not all parts of the mountainous areas of Fort Sill provide suitable vireo habitat, even after disturbance, some determination of soil, aspect, slope, and geology capable of supporting vireo habitat should be made. In addition, some assessment should be made of the current amount of potential vireo habitat through inspection of aerial photography or via remote sensing and GIS technology.

The most useful variables for distinguishing vireo habitat are those related to data from vegetation profiles. Profiles in both horizontal and vertical planes have been emphasized in characterizing habitat structure of bird habitats (Cody 1985). Several monitoring options are being explored with Fort Sill staff, including application of LCTA technologies (Tazik et al 1992a).

## 5 CONCLUSIONS AND RECOMMENDATIONS

1. At Fort Sill, in and around Arapaho Point and Mount Sherman, there are areas on poor rocky soils that support low-growing scrub, which are well-suited for the black-capped vireo. Although not all suitable scrub habitat within these areas is occupied every year, these are the most likely to consistently harbor vireos on Fort Sill. Other areas on the installation appear marginal.

2. Since the rugged terrain at Arapaho Point and Mount Sherman is not suited to tactical vehicular use or other training activity carried out on the installation, presence of vireos there is not likely to affect the Fort's ongoing mission, nor is Army activity likely to impact the vireo.

3. The number of black-capped vireos observed on Fort Sill was small, and had declined (by about 60 percent) between 1988 and 1989. In such small groups of vireos, such declines are within the range of natural variability, and do not necessarily result from military activities.

4. The continued presence of vireos on Fort Sill is expected because of: (1) their previous occurrence, (2) the availability of suitable habitat, and (3) the existence of a more substantial population on the adjacent Wichita Mountains WR. However, the numbers of vireos on Fort Sill may vary substantially from year to year, and may be dependent in large part on the reproductive success of vireos on the Refuge.

5. The major threat to the vireo on Fort Sill, as is the case throughout its range, is cowbird nest parasitism. The low reproductive success of Fort Sill vireos can be attributed in large measure to cowbird parasitism. Cowbird control measures to enhance vireo reproductive success should be implemented and evaluated.

6. Fort Sill appears to have more suitable habitat for vireos than the species occupies in any given year. Expansion of the Fort Sill population is possible and could be realized if vireo production on the Refuge continues and some of these vireos disperse to the Fort. Banding has revealed that vireos do traverse between Fort Sill and the Refuge. Cowbird trapping near vireo breeding areas on the Fort may enhance production and population size, but the low numbers of vireos currently occupying the Fort may still vacillate substantially.

To enhance the reproductive success of vireos on Fort Sill, the following measures are recommended:

1. Continue annual monitoring of black-capped vireo numbers, age classes, and reproductive success from May through July at Arapaho Point, Mount Sherman, and other areas where vireos might be found in the future.

2. Continue to band additional vireos each year to develop estimates of minimal survival and to help document dispersal patterns.

3. Look for additional vireos in the vicinity of Arapaho Point and Mount Sherman.

4. Resurvey all potential habitats every 4 to 5 years, or when a substantial increase in vireo numbers is observed on the Fort. Include in the survey all those areas with apparently suitable habitat inventoried during 1988. The sites of recent fires may develop into vireo habitat in 3 to 7 years, and should also be periodically surveyed.

5. Remove cowbird eggs from vireo nests discovered during the course of monitoring or censusing.

6. Implement selected cowbird control measures. Increase control measures in the event of a substantive increase in vireo numbers on the installation or to further enhance reproduction if vireos continue to demonstrate poor fecundity.

7. In line with the design for habitat management and monitoring, data should also be collected concerning habitat use by the vireos, thus identifying specific attributes of the habitat used.

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